Volume 35 July, 1949 *Number 7*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

LUBRICATING
THE MODERN
PAPER MACHINE

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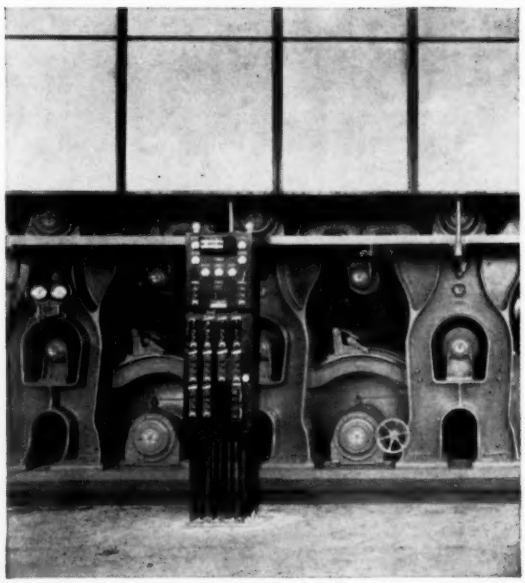

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FOR THE PAPER INDUSTRY

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
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Lubricating the Modern Paper Machine

FIFTY-TWO years ago the May 1897 issue of *Scientific American* contained the following interesting note:

"PAPER MACHINE — At Rumford Falls, Me., the largest paper machine in the world is now in the course of construction by the Rumford Falls Paper Company. It will produce paper 150 inches in width, which is said to be 15 inches wider than any American machine and 2 inches wider than any other machine in the world . . . at the rate of 500 feet per minute, or, in a complete day's run of 24 hours will turn out about 9,000,000 square feet equivalent to 35 tons."

The paper machine has come a long way since this memorable announcement. Comparative figures are significant. "Wider and faster" has seemed to be the slogan, until the modern Fourdrinier machine has grown to 245 inches in width, over 400 feet long and capable of turning out 700 tons of Kraft every twenty-four hours.

OPERATION of today's high speed paper machine, regardless of the type, requires uninterrupted flow of stock to the wire at the wet end. At the same time, operation of the dryer end requires uninterrupted flow of the highest quality lubricating oil to its bearings and drive side gears. Upon these two requirements depends the extent to which the paper industry can satisfy the demands of the "reading, writing and wrapping" peoples of our modern civilization.

Fortunately, in the light of today's lubrication knowledge, the oil can be used over and over again. That is why cost of lubrication per ton of paper produced is virtually insignificant when compared with the total operating and investment cost of the machinery which must be protected by lubrication.

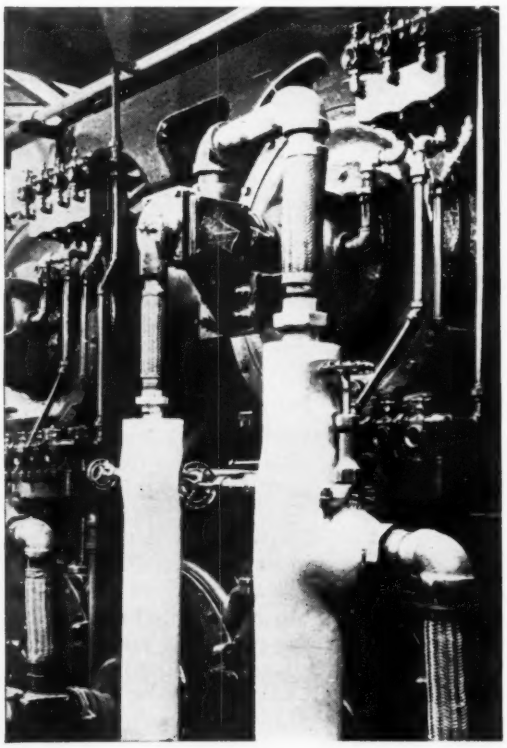
The ancients discovered the art of paper-making. History credits the Egyptians with pressing together thin sheets from the papyrus plant to form a durable material capable of retaining the hieroglyphics which since have told us so much about their early civilization. Perhaps it was about the same time that the Chinese discovered the process of hydrating and interlacing the fibres of bamboo and cotton to make a pulp which they could later press into a type of paper more like what is made today. Without these crude types of paper upon which the scholars could supplement the skills of the artist and sculptor, our knowledge of the customs and habits of these peoples would be very incomplete.

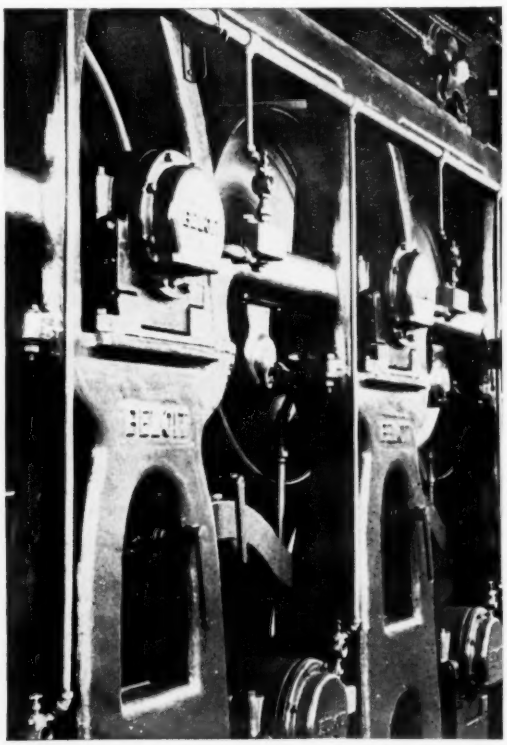
Paper making today is naturally a more intricate art. No longer are we satisfied simply to make paper. It is necessary to make a considerable number of varieties, all the way from facial tissue to box board. The basic processes are the same, but the paper maker today must have a dual skill — he must know the chemistry and physics of pulp formation because every type of paper starts with its own type of pulp; also he must know the mechanics and thermodynamics of drying because every type of paper must be dehydrated, pressed and perhaps calendered, according to the purpose for which it is to be used. For example, tissues need not be glazed but book paper requires most careful calendering.

These are all facts which are well known to the paper maker and which cause him today to study his machine operations most carefully. Machine operation naturally leads one to think of lubrication. This is a most important item because it has such an influence on the rate of production.

In reality, it means that investments of over a million dollars are protected by only a few hundred dollars worth of oil and grease. Accordingly, this article will deal with lubrication of the modern paper machine.

Two distinct types of paper machines are in use today viz.; the Fourdrinier, which is the most commonly used for newsprint, Kraft and the other more durable grades of paper, and the cylinder or vat machines on which paper board and tissue are produced.





Courtesy of Beloit Iron Works

Figure 1—Typical front side and back side dryer bearing oil piping installations on a Beloit Machine.

THE FOURDRINIER MACHINE

Wet End Operation

While the paper machine was invented by Louis Robert, a Frenchman, in 1798, it remained for Henry Fourdrinier to put this novel process of continuous manufacture of paper into actual production in England early in the 19th Century. Hence, the name by which the machine is known today.

Two distinct parts are involved:

(a) The Wet end where the paper stock which is largely composed of water is led onto a "wire" which carries it over a series of rolls and suction boxes, each of which aids in removal of some of the water and,

(b) The Dry end where the embryo paper is finally dried and calendered, according to the type being made.

The "wire" which is of fine copper, bronze, monel or stainless steel mesh is an endless screen onto which the paper stock flows from the stock chest or headbox. As much water as possible drains off the wire as it moves rapidly in the direction of flow. The regularity of motion of the wire is most important for upon this will depend its useful life.

A series of parallel table rolls carry this wire and enable the formation of a flat table surface for the first stage in making paper. The first roll of this set is called the breast roll. Below these rolls a saveall is located which collects water drainage from the stock on the wire.

Suction Boxes Are Under Partial Vacuum

After the wire has passed over the table rolls, it is led over suction boxes in which a partial vacuum is maintained, to aid in further removal of the water.

During the process of preliminary formation, the embryo layer of paper in some types of machines is prevented from spreading or flowing off the edges of the wire by endless rubber belts, known as deckle straps; these are carried along by the wire. When this latter, with its layer of paper, reaches

the last table roll, it passes the layer under a lightweight top roll (called a dandy roll), which smooths the surface of the partially dehydrated sheet.

Pressure Starts at the Couch Rolls

After this, the stock is passed between a set of couch rolls which add the effects of pressure in squeezing out of some of the water. Since pressure must be available on the top couch roll, its bearings must be so designed as to enable effective lubrication under this pressure. Usually the bottom couch roll is connected through a clutch to a driving unit which serves as the drive for this entire end of the machine. At the couch roll the web of paper is sufficiently bound together by its fibres so that it can carry its own weight.

The Press Rolls Follow

Now that the web can support itself, it leaves the wire, which is returned to the breast roll over return rolls located beneath the table rolls. The web, in turn, is passed to an endless woolen felt, which carries it between the press rolls. To avoid tearing the web the pull exerted by the press rolls must be uniformly even and continuous. The number of these rolls will depend on the design of the machine, two or more being used according to the service.

The bottom roll serves as the drive, the top elements being weighted in a controlled manner to enable varying the pressure, according to the amount of dehydration to be accomplished. Lubrication is important at this stage as both pressure and water contamination must be considered.

In higher speed machines, suction is also included in connection with the press rolls. There the suction element is known as a suction press roll. It is located below the sheet, serving also as a press roll. In general, the suction press roll carries a perforated shell, containing within itself a stationary suction chamber connected to a suction pump.

THE CYLINDER OR VAT MACHINE

This machine which also makes paper continuously is widely used for tissue and box board manufacture. Here a wire also is used for preliminary formation of the web by dehydration or draining. In this case, however, the wire is stretched on a cylindrical framework which rotates in a vat of paper stock. As the hollow cylinder roll revolves, the fluid stock tends to flow through the wire mesh, leaving a deposit of fibrous material on the outer surface of the screen. The drainage flows to a saveall.

A difference in level is maintained between the water inside the cylinder and the paper stock in the vat in order to develop sufficient suction to build up a considerable web or film of fibres on the surface of the rotating cylinder. This film which is called a web is then picked up by an endless woolen blanket, or bottom felt, being squeezed into close contact by a top couch roll. This web can be built up layer by layer by using additional cylinder rolls according to the final thickness desired.

While the cylinder process involves somewhat of a variation in construction, the essential principles of operation are very similar to those of the Fourdrinier, so they present no real difference from a lubrication point of view, the question of resistance to water wash and pressure being the chief requirements to consider when selecting lubricants.

THE PROCESS OF DRYING

The paper sheet as it leaves the wet end of either a Fourdrinier or cylinder machine, after passing through the press rolls still contains at least 60% water. It must, therefore, be subjected to a series of drying operations to remove the remainder of this water. The process of drying involves a continuation of the rolling action already begun on the wet end. At the dry end, however, the roll mechanisms consist of a series of hollow cast iron cylinders, heated internally by steam. There may be from fifty to one hundred of such dryers according to the size and type of machine.

These rolls run in synchronism, being geared together at their journals or operated by chain drives in order to function in absolute unison with each other, thereby subjecting the felt to virtually constant tension. The sheet is passed to the first set of dryers directly from the press or felt rolls.

The arrangement of the dryers has a good deal to do with the finished surface of the paper. A method of developing a glaze is to operate one large roll of this nature in conjunction with a series of smaller press rolls. To a certain extent this anticipates the function of the calender stack.

LUBRICATION – AT THE WET END

Lubrication of the modern paper machine is affected by:

(a)—The type of bearings
(b)—Contamination by water or pulp
(c)—Temperature
(d)—The method of lubricant application.

Bearings

These are of plain or sleeve-type, or they may be ball or roller. The former are generally built of some conventional babbitt metal and are grease or oil-lubricated. Ball or roller bearings are of a type dependent upon location on the machine. The heaviest duty prevails on the parts approaching the dryer section. Ball and roller bearings designed for grease lubrication by means of individual pressure

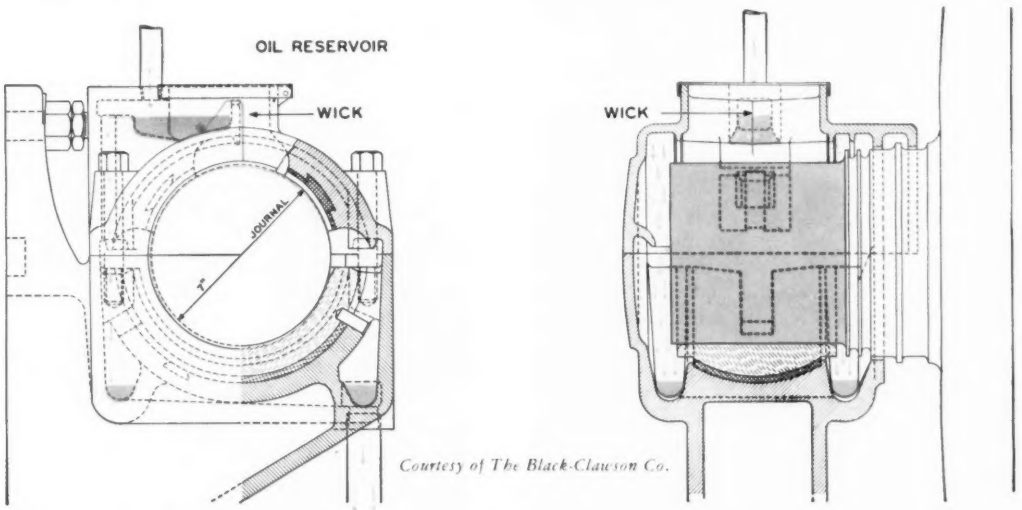
gun fittings are applicable to table rolls. Roller bearings are well suited to the press and couch rolls where pressures are higher.

Contamination

This used to be a serious factor, and often a deterrent to good lubrication. Today the bearings are sealed more effectually so there is not as much chance of water and pulp entering to contaminate the lubricant. Contamination is a possibility in any lubricating system, however, and where the volume of contaminating materials is so high, as in the paper industry, it must be checked at regular intervals. Experience with the bearing housings will dictate how often.

and reservoir oiling device will contribute to effective lubrication since it will not only insure automatic, readily controlled delivery of oil, but also will largely eliminate the uncertainty due to the human element where individual lubrication is necessary. By use of a manifold and circulating system, the operator will be almost entirely relieved of the necessity to attend to such bearings, except where oil reservoirs are to be refilled or wicks stripped.

When a compounded oil is used, wicks should be stripped or cleaned every few weeks to prevent gumming and clogging of the pores of the material. Otherwise free flow of oil would be retarded. Use of too heavy an oil might lead to the same condition.



Courtesy of The Black-Clawson Co.

Figure 2—Showing front side bearing details of the oil circulating system for a Black-Clawson plain type dryer bearing. Note the wick provided in the oil reservoir in the bearing cap, which feeds oil to the top of the journal. With such an arrangement approximately one pint of oil per minute is circulated through each bearing without flooding. The oil reservoir holds about one quart of oil; this insures that emergency lubrication will be provided temporarily in case of interruption of the main oil supply. Flinger rings turned on the journal cause any drops of oil to drip off or be thrown off, depending upon the speed. The additional rings in the dryer journal and bearing caps tend to prevent dust and lint from working in from the top.

Temperature

The overall temperature range at the bearings of a paper machine is wide; the ranges at the wet end and dryer sections, respectively, however, are narrow; i.e., at the wet end the temperature is that of the stock as it is fed to the wire.

Method of Lubricant Application

Unit lubrication prevails on the wet end bearings. Pressure grease lubrication is well suited for the table roll bearings and those of the press and couch rolls. Bearings which are designed to retain grease do a good job in preventing entry of water and pulp, thereby reducing lubricant contamination.

Wick Feed Oiling

On plain bearing rolls an automatic wick feed

Lubricant Characteristics

Grease type and consistency

An N.L.G.I. No. 1 or No. 2 consistency grease is usually preferred for the wet end bearings.

The relative water solubility of a grease for such service, is important. Some authorities prefer a soluble soda soap product since in the presence of normal amounts of water, it will develop lubricating emulsions. There is no reason why this should be an advantage, if high quality, oxidation resistant lime soap products of medium consistency are properly applied. In fact, a properly compounded non-soluble lime soap grease will retain its original homogeneity and in the presence of average temperatures will develop a good water seal at the ends of the bearings.

Type of Oil

Wet end bearings which can only be lubricated with oil, employ wick feed, sight feed or bottle oilers. Here, to prevent possible rusting of roll necks some operators like to use a compounded oil, selecting a product of from 600 to 700 seconds Saybolt Universal Viscosity at 100° Fahr.

Importance of Lubrication

This has a two-fold meaning to the management.

(1) Preservation of the wire.
(2) Even feed of stock.

Tension on the wire must be kept as even as possible. To be assured of this, table rolls in particular, must not drag or stick. In other words, they must be kept properly lubricated. Uneven feed of the stock, in turn can cause variations in pressure on the roll bearings.

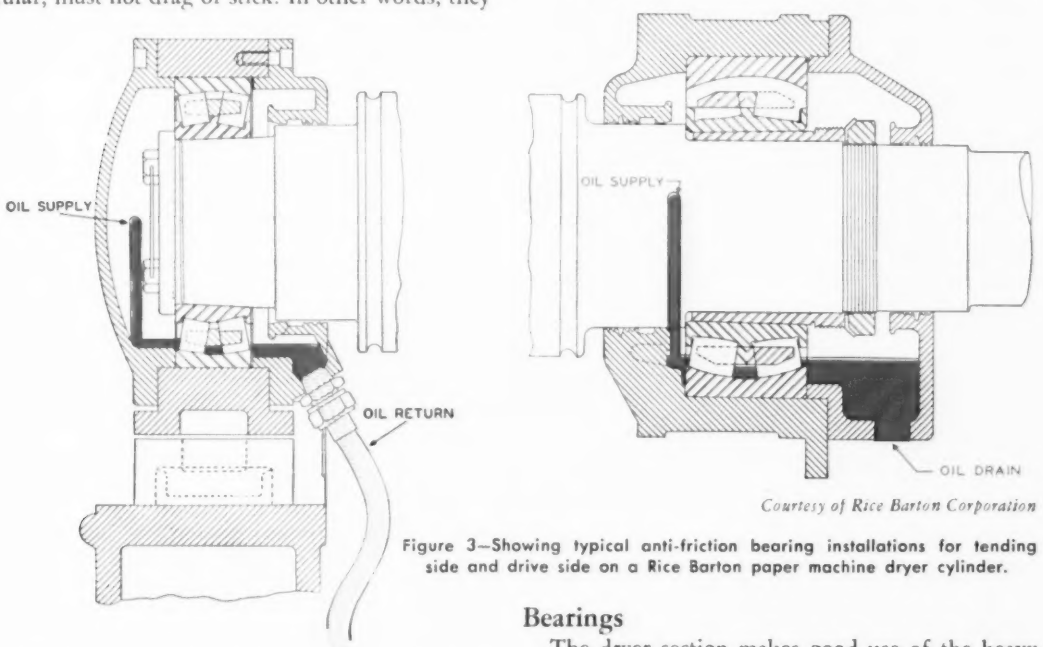
Table roll bearings usually are not subjected to any abnormal pressure, and they operate fairly cool due to the presence of water. Yet, they may contribute to high costs of lubrication and production should they tend to drag or stick, to ultimately cause flat spots on the roll itself, due to the friction of the wire. Continued operation under such conditions would not only be costly if table roll replacement is required, but also it might seriously affect the uniformity and quality of the paper.

Another costly item may result from abnormal wear developed on the wire itself due to uneven tension. Uneven pull with any accompanying wear or tendency in the wire to twist out of shape will ultimately necessitate replacement of this material. The resultant drag on the table roll bearings reacts on the drive, which is ordinarily accomplished through the lower couch roll.

LUBRICATION AT THE DRYER SECTION

The factors which may affect lubrication of the bearings and gears at the dryer end of the paper machine include:

(a)—The type of bearings.
(b)—Oil contamination by moisture or dust.
(c)—High bearing temperatures.
(d)—High bearing pressures.
(e)—The way the oil is applied.



Courtesy of Rice Barton Corporation

Figure 3—Showing typical anti-friction bearing installations for tending side and drive side on a Rice Barton paper machine dryer cylinder.

Bearings

The dryer section makes good use of the heavy duty roller bearing or precision type sleeve bearing. These bearings are most carefully designed, with the purpose of assuring maintenance of dependable lubrication. This has reacted favorably upon the unit cost of lubrication per ton of paper, as well as the cost of maintenance.

Contamination

The possibility of oil contamination becomes more remote as the paper approaches its finished state, in passing over the various rolls included in the dryer section. Yet, water may be present if steam joints are leaking. As a general rule, however, moisture contamination of oil in the circulating lubricating system at the dryer section is generally induced by condensation. At this stage, the paper is sufficiently dry so that there is but little possibility of an excess of water being present. As the

finishing stage is approached there is however, more possibility of paper dust or fluff developing, to find its way into the lubricating system.

Temperature

The bearing and gear case temperatures at the dryer section are influenced by the steam which is used. Bearing temperatures can exceed 300° Fahr. The rate of oil feed plays an important part. It must be worked out by experience, based upon records kept on the machine involved.

rolls in order to develop the necessary squeezing and final drying of the web are of necessity imparted to the bearings which carry these rolls. These pressures are most effectually counteracted by flood lubrication in the roller bearing, or by fluid film lubrication induced by flood lubrication where plain sleeve-type bearings are used.

Bearing pressure must be considered on many modern machines. This has increased with increase in speed. Obviously heavier loads need greater durability in the lubricating film. This requires prior

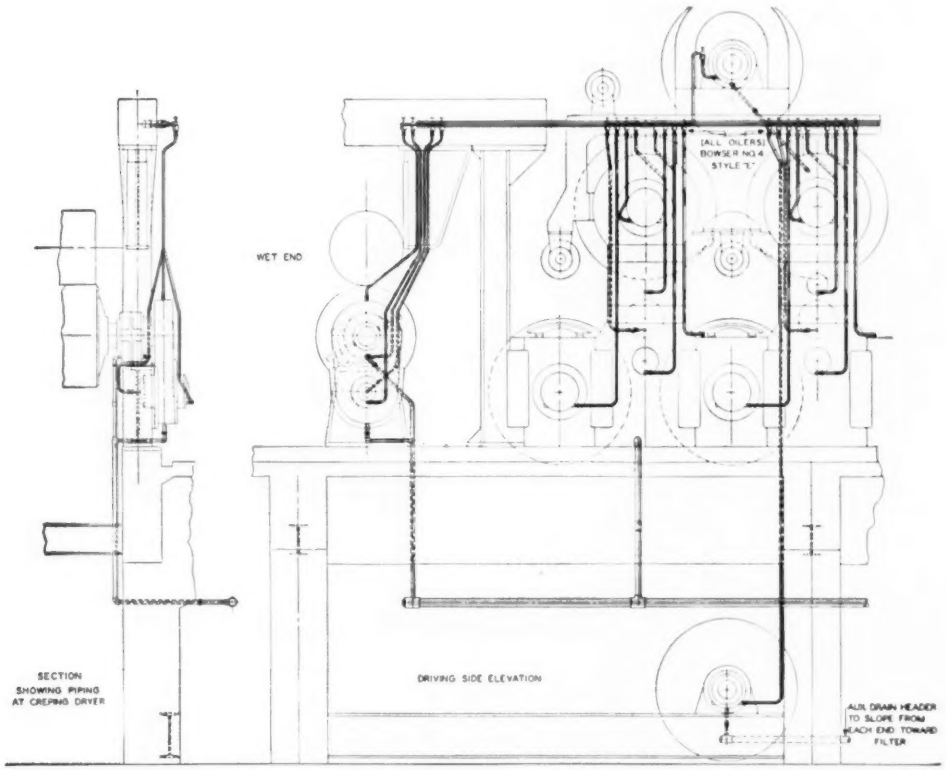


Figure 4—Dryer section lubrication system for the new Pusey & Jo... St. Regis Paper Co. Red shows the flow of the oil to the bearings ... system where the oil is reconditioned before re-circulation. SKF Spher... and lucite windows on tending si...

High temperatures must be considered, especially if the machine is to be run at high speed (in terms of feet of paper produced per minute) to meet high production schedules. Then they literally "turn on the heat" to speed up the rate of drying to conform to the running speed of the machine. Under these conditions, temperature control is an important factor. It is obvious that the circulation of even low pressure steam through the dryer rolls must lead to a heat condition at the bearings which can be controlled only by the cooling effect of lubrication supplemented by water cooling in some cases.

Bearing Pressures

The comparatively high contact pressures which must be maintained between the surfaces of the

consideration of load-carrying capacity over heat transfer ability, for the latter can be controlled by increasing the volume of oil circulated through the system and the use of oil coolers if necessary.

Lubrication by Oil Circulation

The oil circulating system, as designed for the modern paper machine, has required the most careful engineering in planning the distribution and return piping, tankage for the oil storage and filtration unit, and pumps of adequate capacity to keep a full stream flowing through the bearings all

the while the machine is in motion.

The dryer end section of the paper machine offered one of the most promising points for improvement in means of lubrication by application of oil circulation, with provision for adequate and continuous reconditioning. This became all the more apparent with the application of the heavy duty roller bearing and the means which the bearing engineers provided for oil sealing. It involved a mechanism which would benefit materially through oil lubrication, supplied under controlled pressure at sufficient volume to flood the bearings continually, the oil thereby serving as a heat transfer agent, as well as a flushing medium. It only required study on the part of oil filter designers to plan the system to keep the oil in service at a sufficient degree of cleanliness to insure its lubricating ability.

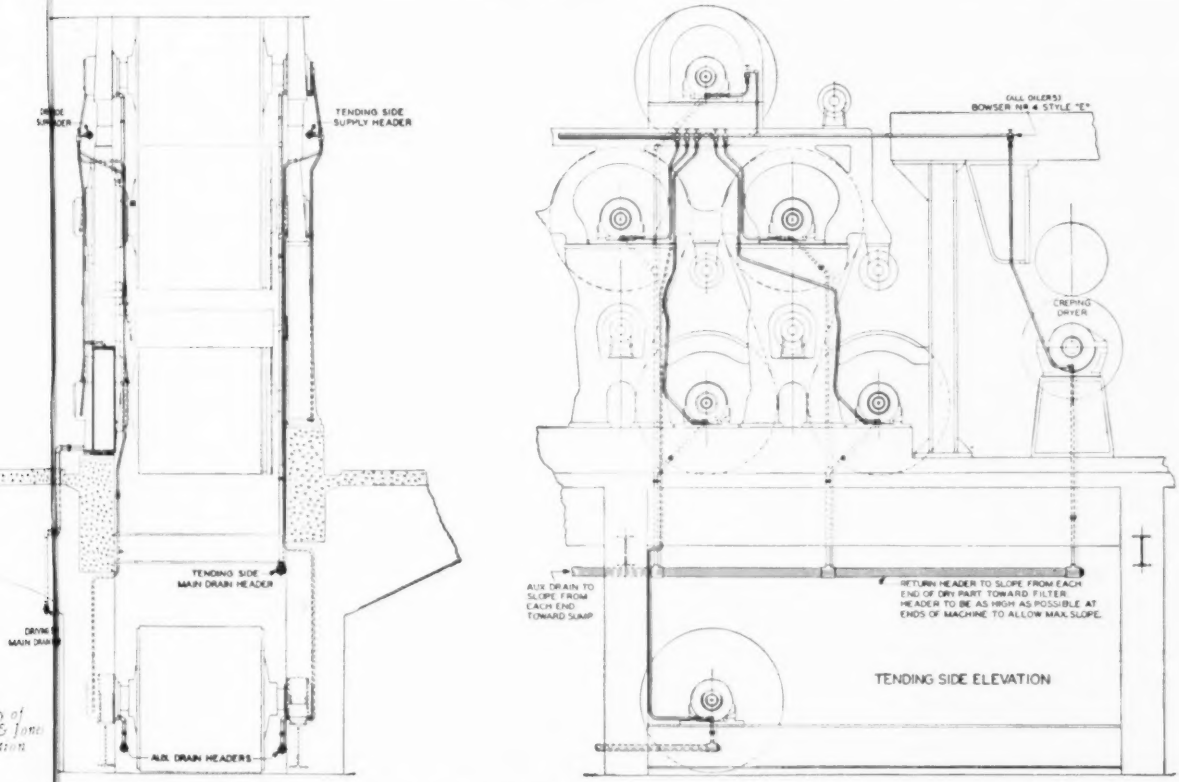
Very high rotational speeds are not customary (in terms of R.P.M.) although the surface speeds may be high due to the large diameter of the bearings. Furthermore, some bearings are very inaccessible; for example, the bearings on the drive side are frequently almost impossible to reach due to the dependable method of drier bearing and gear lubrication where so many costly bearings are involved. The perfection of the heavy duty roller bearing and the oil tight gear housing also were contributing factors. The principle is to circulate relatively cool, clean oil under uniform pressure from a central reservoir to bearings and drive gears to provide proper lubrication and to remove heat from the contact surfaces. This keeps the operating bearing and oil temperatures within reasonable limits.

driving gears. That is why automatic lubrication has been so widely installed.

How Oil Circulation Is Maintained

A variety of ways have been devised for developing oil circulation ranging from the unit type of gravity feed system to those multiple outlet devices whereby an entire series of sleeve type or roller bearings can be served simultaneously under the same constant pressure.

The latter is very often preferred as the most



y & Jo…ight speed paper machine at the Tacoma, Washington mill of the …earings & gears; Green shows the discharge and drains to the Bowser filtering …KF Spher…oller bearings are installed on each dryer, with floating design mounts …ding si… facilitate observation at all times.

Full Pressure Lubrication

In a full pressure system a supply pump delivers oil at a predetermined pressure from the settling tank to a pressure tank in which an air cushion is provided at the top. Usually two pumps are pro-

vided, one of which may serve as a spare. This latter cuts in automatically, by means of electrically operated pressure switches when the pressure in the pressure tank drops below a predetermined minimum, due to failure of the operating pump, or whenever the latter is unable to maintain the desired pressure. If both pumps fail or are unable to maintain sufficient pressure, a third pressure switch, which is set just below the minimum operating pressure required, sounds an alarm. A pressure regulated by-pass valve in the supply line to the machine allows any excess oil to return to the clean oil compartment of the filter tanks.

The expansive action of the air cushion in the pressure tank forces the oil through the main supply line and the numerous branch lines; these are equipped with orifice plates or valves, to provide each bearing or gear unit with its proper share of lubricant. Frequently each of the various points of lubrication are equipped with a pressure switch and light signal to warn the operator, should the oil flow be interrupted. The return oil from the gears or bearings flows back to the settling tank by gravity; here it is subjected to filtration and purification to fit it for recirculation.

Pressure Oiling by Gravity

When gravity pressure is employed the supply pump delivers oil from the settling or sump tank to an overhead supply tank which is mounted high enough to give ample pressure to the oil flow to gears and bearings. An oil overflow line from the overhead tank to the sump tank returns all surplus oil delivered by the pump. From this overhead tank, a supply header, through an assembly of distributing lines, delivers oil by gravity to the various points to be lubricated; the oil then returns by gravity to the sump tank located below the operating floor.

Gravity circulation reduces the intricacy in construction and the necessity for costly automatic controls, but it is limited in regard to available pressure due to plant conditions. Where this pressure is low, it may influence the choice of the viscosity of the oil.

Oil Tanks

With the possible exception of the circulating pumps, the oil tanks are the most useful and necessary features of the circulating system. Normally the tanks are divided into two compartments, viz.: the settling or receiving compartment and the clean oil or supply compartment. Where there is any chance of considerable water getting into the system, and where tank temperatures may be below 125° Fahr., provision for heating is advisable. Exhaust steam coils located in the bottom of the tank can be used for this purpose, to bring the oil to a temperature of 150° to 170° Fahr., to enable the entrained water to settle to the bottom from whence it can be drawn off through the drain valves.

A well-designed settling tank will have several large clean-out ports located along the front and as near the bottom as possible. It is also desirable to slope the bottom of the tank toward the front; then by periodically opening the drain valves, the accumulation of water and sludge in the tank can be held to a minimum. Floating suctions are also often installed to allow the pumps to take the cleanest oil, which is found near the surface in the tank.

Any oil tank should be of sufficient size to allow the oil to flow through at minimum velocity with ample time for settling and filtering; thus the oil entering at one end has an opportunity to drop out a considerable amount of its entrained moisture and contaminating foreign matter and be properly filtered before it again reaches the pump suction at the other end. The tank should be kept as nearly full of oil as possible, due consideration being given to the expansion of the latter, because a full tank reduces the exposed surface on the inside of the tank and prevents excessive sweating; also it aids in the cooling of the oil, and allows more time for the oil to drop out any contaminants.

The capacity should be sufficient to permit a feed of one gallon per minute for each dryer roll (including bearings, gears or chains) with a rest period of ninety minutes, i.e., for a 50 roll machine the tank capacity should be 50 x 1-gal x 90 = 4500 gallons.

Oil Filters

As stated the oil tank normally is divided into two compartments, one side acting as a receiving or settling compartment. From this compartment the oil passes through bag type filters for removal of water or solid contaminants before going into the clean oil or supply tank.

Ample capacity for filtration of the lubricating oil should be provided so as to assure clean oil for the bearings at all times. In addition to the bag filters, the system should include a pressure filter located on the discharge side of the supply pumps.

The Oil Cooler

In some cases, an oil cooler of ample size is desirable to lower the temperature of the oil leaving the pressure tank. For best results, an ample supply of cooling water must be provided for the cooler, and the latter must be kept clean. Thermometers inserted in the oil lines entering and leaving the cooler indicate the efficiency of the cooler.

Centrifugal Purifiers

A circulating system may also include one or more centrifuges which are usually operated inter

mittently for an hour or so each day. Where large quantities of water may get into the system, however, the centrifuges are sometimes run continuously until the source of the water is located and the leak corrected.

LUBRICANT CHARACTERISTICS

Grease – Type and Consistency

Although most modern paper machines utilize oil for the dryer roll bearings, there are some which require a grease. For dryer roll bearings of this type a block grease or one packed in knitted tubing is required. These greases have a high melting point and contain comparatively high viscosity oils in their composition.

For felt idler rolls equipped with anti-friction bearings, the same grease which is used for the wet end bearings may be used provided the temperatures are not too high. Where temperatures are high as a result of higher steam temperatures. The grease should have a melting point sufficient to withstand the temperatures encountered.

The Oil

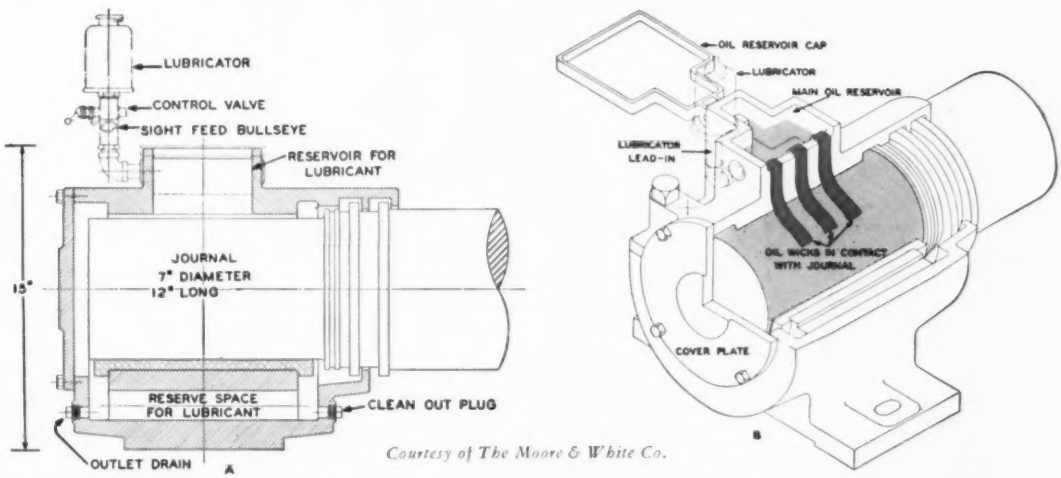
Dryer section operating conditions require an oil of the very highest quality with adequate oxidation resistance, having good rust protecting ability and some detergency. Normally a viscosity ranging from 60 to 100 seconds Saybolt Universal at 210° Fahr. will be suitable according to the condition of the bearings, means of application and temperatures.

Resistance to Oxidation

An oil which has been fortified to resist oxidation is preferred by machinery builders and operators today. Circulation of fluid oils under uniform pressure conditions is helpful in reducing operating temperatures through the cooling effect of an excess of comparatively fresh cool oil. This emphasizes the need for oxidation inhibitors since heat accelerates oil oxidation, as also does exposure to metallic particles, dust, moisture and air. Sludge accumulations and increase in the neutralization number of the oil indicate that oxidation has occurred.

Detergency

The ideal circulating oil, in addition to performing its function as a durable lubricant, and as a coolant for dryer end bearings and drive gears, also must possess a certain amount of detergency as stated above. This denotes its cleansing ability which may be a very important property when the oil is added to a circulating system which has accumulated a considerable amount of products of oil oxidation, paper dust, sludge and water. Very often such accumulations are gummy and difficult to remove without dismantling the system, unless a replacement lubricant is used which has the ability to also serve as a solvent and thereby loosen the deposits from bearing parts, etc., and carry them down to the filter for removal from the system.

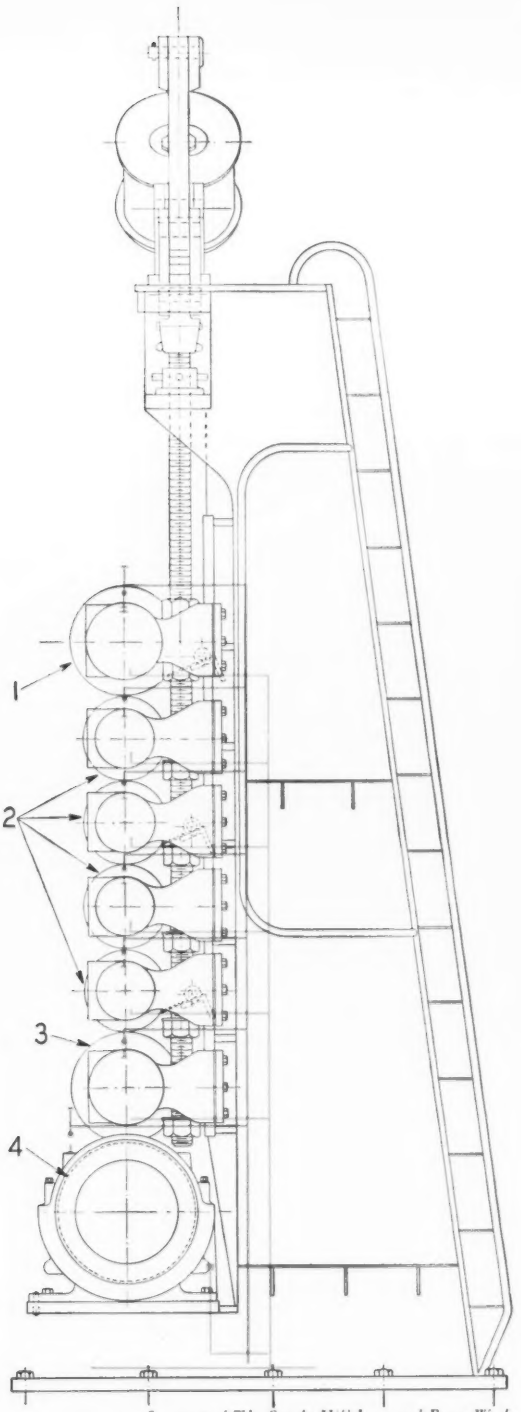


Courtesy of The Moore & White Co.

Figure 5—Details of tending side bearing of a Moore & White 42" dryer on an asbestos machine designed to produce at rate of 30 to 300 feet per minute. A—shows cross-sectional details; B—shows bearing assembly with oil wicks in place. A feature of this design is that it can be converted to grease lubrication simply by removing the oil wicks and shutting off the lubricator; grease being applied directly onto the journal.

Dispersion

It is most difficult to keep paper dust and moisture out of the lubrication system. Therefore, the lubricant should be capable of picking up these materials and holding them in a finely dispersed state so that they may be removed from the bearings and lines and carried to the settling tank and filters for separation from the oil.



Courtesy of The Sandy Hill Iron and Brass Works

Figure 6—Side elevation of a Sandy Hill Iron and Brass Works calender stack showing details of oiling system. Red indicates oil to bearings; Green indicates oil return lines. 1—indicates 16″ top roll; 2—indicates the 12″ intermediate rolls; 3—is the 16″ next to bottom roll; and 4—the bottom roll.

Rust Prevention

When dryer bearings are highly finished steel, anti-friction type, the oil also should have positive rust inhibiting characteristics. It is realized that moisture is ever present in a paper machine lubricating system, therefore it is imperative that the lubricant be capable of preferentially wetting all parts in order to prevent rusting.

Film Strength

The lubricant must not only conduct heat from the bearings, keep the system free from water, dust and deposits but must also afford ample protection to the bearings by the prevention of wear. This means that an oil of good load carrying capacity is vitally necessary.

Procedure When Introducing Oil into the System

An oil having the above characteristics will function most effectually when it is added to the circulating system according to a procedure worked out by the oil supplier. Detergent-type oils in particular must be handled so that their detergency or cleansing ability is most effectual. This will assure of a clean, efficient lubricating system for future operations. The procedure depends upon whether:

(a) The oil is introduced into a new system or one which has been thoroughly cleaned.

(b) The oil must be introduced into a system, known to be dirty, without stopping the machine.

(c) The oil is introduced as make-up into a system containing a different brand of oil. Here it is important to check the compatability of the two oils.

Benefits of Proper Lubrication

The benefits of proper lubrication can be summarized as follows:

(a) It assures of continuity of operation.

(b) Maintenance costs are reduced, by:

1. Elimination of bearing failures due to rust.
2. Elimination of periodic manual cleaning of bearings or lubricating system.
3. Elimination of rust.
4. Improved gear and chain life.

(c) Higher operating speeds and temperature can be safely maintained.

(d) Oil consumption is decreased.

(e) Production of high quality paper is maintained.

THE CALENDER STACK

The calender stack imparts a high finish or glaze to the paper web as it leaves the dryer, when such

a finish is desired. Calendering is in reality an ironing process. The higher the finish the greater will be the pressure and the higher the surface speed of the rolls. So the duty imposed upon the roll bearings can be severe.

The Bearings

These may be either anti-friction (roller) or plain sleeve type. They may be either oil lubricated by a circulating system, or pressure grease lubricated by grease gun.

Oil Contamination

At this stage of paper making any contaminant which may enter the lubricant is usually paper dust, although there may be some possibility of moisture through condensation, especially if the humidity is high. For this reason, seals must be good.

The Cause of Temperature

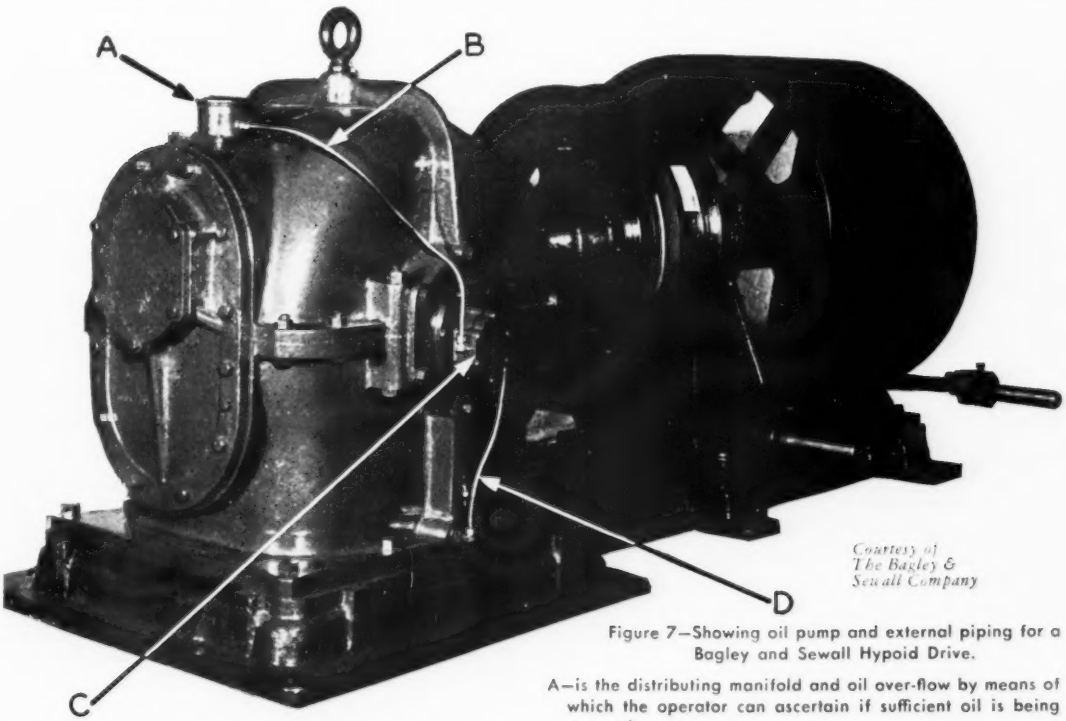
While steam heated rolls are not used throughout the entire calender, the pressures of operation along with crowding frequently develop considerable temperature. To an extent this heat will be conducted to the bearings. On steam heated rolls the bearing temperatures will depend also upon the steam temperature. As in the case of dryer section bearings, the temperature of calender stack roll bearings can be partially controlled by regulating the flow of oil, and in some installations by water cooling.

Pressures

Bearing pressures, as stated will depend upon the way the stack is run, with respect to speed and the finish desired. As the bottom and second rolls carry the weight of the upper rolls, obviously the pressures on the lower roll bearings may be considerably higher than on the upper bearings. In a sleeve bearing installation the oil film must carry this pressure, with adequate film strength to take care of boundary lubrication during periods of low speed operation when starting or stopping.

Lubricant Application

Prevailing practice in the application of roller bearings to calender stacks provides for an oil reservoir as a part of each bearing with suitable means for checking the oil level. Circulating pressure lubrication is most dependable in maintaining the required oil films. In the opinions of certain authorities the oil overflow from each bearing should be so planned as to always leave a certain amount of oil in the base of the bearing, to provide reserve lubrication in case of interruption or failure of the oiling system.



Courtesy of The Bagley & Sewall Company

Figure 7—Showing oil pump and external piping for a Bagley and Sewall Hypoid Drive.

A—is the distributing manifold and oil over-flow by means of which the operator can ascertain if sufficient oil is being pumped.

B—is the oil pressure pipe from the pump to manifold.

C—is the gear type pressure oil pump.

D—is the oil suction line from the reservoir in the base to the pump. The oil lines distributing the oil to the various bearings are inside the case.

On sleeve type bearings ring or collar oilers have been used. Combined with an automatic circulating system, a ring or collar oiler provides a very dependable lubricating system.

Dependent upon the design, the calender stack may or may not be on the same oiling system as the dryer section. Some authorities favor using two separate systems with an independent set of tanks, pumps and filters, so that failure of either one would not affect bearing protection by the other. This would also insure against contaminating the entire volume of oil.

Type of Oil

In any event, the same type of high quality oxidation and rust resistant detergent oil as is used so successfully today in modern paper machine dryer section lubricating systems, should be used in the calender stack system.

Type of Grease

When calender bearings are anti-friction type with means for grease lubrication by pressure gun, a high quality anti-friction bearing grease designed to function under high temperatures is used.

Importance of Maintained Lubrication

Obviously, if a calender stack has to be shut down due to faulty bearing lubrication, production of paper stops. This is why lubrication of modern calenders is so carefully studied.

STEAM JOINTS

Steam is fed to the dryer rolls through steam joints on the drive side of the rolls. These joints must be kept free from leakage by tightening, although a joint should never be screwed up so tightly as to cause wear. Steam leaks can cause:

(1) Loss of valuable steam.

(2) Water in the bearing oiling system exposing roller bearings to rusting action and contributing to formation of sludges in bearing housings and oil ways.
Water also places an additional burden on the system oil by the necessity of removing this water even before evaporation occurs, to prevent tacky sludge emulsions and oil oxidation products.

(3) Rusting of gears.

(4) Insufficient drying.

Steam joints designed for lubrication can be adequately protected by cylinder oil or grease; either, when properly applied to the face of the moving parts will insure proper lubrication, the prevention of wear and consequently steam leakage. The grade of steam cylinder oil employed elsewhere in the plant will usually be satisfactory for such joints.

THE DRIVES

The dryer rolls are connected through a gear train consisting of spur or helical gears, or by means of roller chains to synchronize their rotation and maintain the proper tension on the paper passing between them.

In most modern machines these gear trains and chains are enclosed in an oil-tight housing and are lubricated by a circulatory system which is similar to, or is the same system, which lubricates the bearings. Being on such a system assures that an adequate supply of clean protective lubricant is provided at all times. The same characteristics of the lubricant for the bearings are highly desirable for the lubrication of these gears and chains in order to assure minimum wear, protection against rusting and freedom from deposits.

Some machines, however, may be equipped with gears which are exposed; a lubricant having good adhesive qualities and capable of withstanding relatively high temperatures is required for this service. This type of lubricant may be applied by brushing or pouring onto the gears or by dripping on to the teeth either by gravity or a mechanical lubricator.

Herringbone, spiral bevel or hypoid gears, are used as main drives for operating the calenders. Generally they are lubricated by a self-contained system as they are subjected to severe tooth loading and rubbing. This combination which is most serious in a hypoid drive, can easily cause gear failure if the right lubricant is not used.

The mild E. P. type non-corrosive gear lubricant is favored for hypoid gears. The extreme pressure characteristics are permanent; the ingredients do not separate in storage or service and this type of lubricant is adhesive to the gear teeth.

CONCLUSION

Dependable lubrication of the modern paper machine can best be assured when the lubricants are selected with due respect for the investment involved. It should stem from the time the machine is laid out on the drafting board. The petroleum chemists were not oblivious to the advancements being made in paper machinery design, and they have produced lubricating oils and greases which are outstanding for their durability, resistance to oxidation, their capacity for retarding rusting, and —in case of circulating oils—their detergent ability. But these products must be used properly. They must be applied according to proven methods of procedure. The day of the "oil can" has passed. Machinery worth over a million dollars per machine demands the insurance of precision lubrication.

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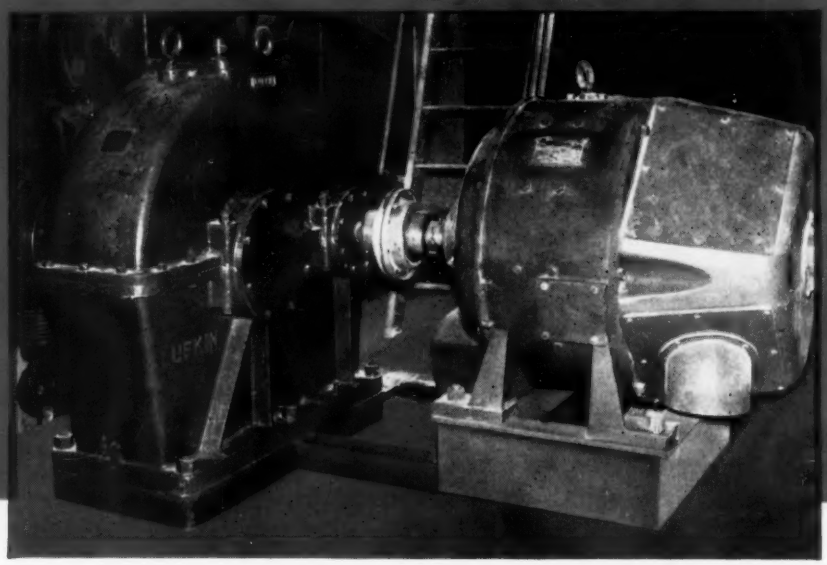

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